IMPACT: International Journal of Research in Engineering & Technology (IMPACT: IJRET)
ISSN(E): 2321-8843; ISSN(P): 2347-4599
Vol. 2, Issue 7, Jul 2014, 81-84

SOLAR IRRADIATION PREDICTION USING NEURAL NETWORK

AKHIL SAOKAR[1], SHREYANSH JAIN[2] & ARUNA GAWADE[3]

[1,2]U.G. Student, Department of Computer, DJSCOE, Vile-Parle (W), Mumbai, Maharashtra, India

[3]Assistant Professor, Department of Computer, DJSCOE, Vile-Parle (W), Mumbai, Maharashtra, India

ABSTRACT

In recent years, introduction of a renewable energy source such as solar energy is expected due to the expected depletion of other conventional energy sources. Solar energy is one of the most promising renewable energy sources. In order to integrate this type of source into an existing power distribution system, system planners need an accurate model that predicts the availability of the generating capacity. In order to predict this to a successful extent, an artificial neural network is applied. This paper shows the results of our earlier proposed neural network model used for prediction of solar irradiation, as well as compares outputs from various neural network models based on supervised learning rules and Error Back Propagation Training Algorithm. The irradiation and other training data of one year (December 2012 to November 2013) have been obtained from Tata Power Company's Mulshi Solar Power Plant.

KEYWORDS: Artificial Intelligence, Solar Energy, Solar Irradiance, Neural Network, Prediction, EBPTA, Feed Forward

INTRODUCTION

The world is facing the threat of depleting fossil fuel resources which could cause a major setback to the world. Researches show that the fossil fuels will get depleted completely in the coming years. The existing system for power generation uses non-renewable resources as a major source which shall soon be depleted. Renewable resources are also being used for power generation but they aren't being used to their full extent. Artificial Neural Networks (ANNs) have been used widely in real world applications, including stock market prediction, flood or disaster prediction, medical diagnostic system, etc. With the advent of the need for efficient reusable energy, ANNs have now also been implemented in Solar Energy Prediction or Solar Irradiance Prediction nowadays.

ANNs are appropriate tools for solving real problems in the cases where classical methods are insufficient. Artificial Neural Networks (ANNs) is an efficient information processing system which resembles in characteristics with a biological neural network. ANNs can easily adapt to changing situations and timely variations. The ANN model that had been proposed in [1], to estimate solar irradiation in Tata Power Company's Solar Power Plant at Mulshi is based on several input parameters. This study utilizes the commonly available parameter of sunshine hours, irradiation intensity, geographical locations of the power plant, etc. to develop an easy to use ANN model, using data covering a period of one year.

DIFFERENT MODELS

We have tested multiple Feedforward neural networks in MATLAB and the one with best performance is selected for prediction. These models vary in the number of hidden layers and also the number of neurons in the hidden layer.

The different models implemented in MATLAB are as described below:

Table 1: Different Neural Network Architectures

Model No.	No. of Input Parameters	No. of Hidden Layers	Neurons in Each Hidden Layer	No. of Output Neurons
1	8	1	2	1
2	8	1	4	1
3	8	1	6	1
4	8	1	8	1
5	8	1	10	1
6	8	2	2,10	1
7	8	2	4,10	1
8	8	2	6,10	1
9	8	2	8,10	1
10	8	2	10,10	1

The results of different neural network architectures suggest that the performance lies between 0.004 – 0.006 and model no. 4, with 1 hidden layer and 8 neurons in that hidden layer, gives the best validation performance of 0.0040182 at epoch 55.

IMPLEMENTED MODEL

A Feed Forward neural network which has an input layer of 8 neurons, 1 hidden layer with 8 neurons and an output layer with single neuron has been used for prediction of solar irradiation. The error back propagation training algorithm has been used for training the network.

The input parameters to the network are:

- **Geographical Position**

The geographical position of the solar power plant plays an important role in determining the solar irradiance since it is more towards the equator than the poles. Hence, a mix of latitude and longitude of the plant will be used in the model.

- **Weather Conditions**

The cloud cover and temperature of the surrounding area of the plant will be an essential input. As surrounding temperature increases, general solar irradiance values increase. On the same hand, the cloud cover determines if the sun rays will be falling on the PV panels or not.

- **Previous Day Solar Irradiance**

The solar irradiance value on the same time on the previous day would be considered as an input to get a trade-off between hourly/daily short term forecasting.

- **15 Minutes before Solar Irradiance**

A 15 minute earlier solar irradiance value is useful in the case of short term predicting of the same.

- **30 Minutes before Solar Irradiance**

A 30 minute earlier solar irradiance value is useful in the case of short term predicting of the same.

- **45 Minutes before Solar Irradiance**

  A 45 minute earlier solar irradiance value is useful in the case of short term predicting of the same.

- **1 Hour before Solar Irradiance**

  Solar irradiance value of the hour before is useful in the case of short term predicting of the same.

- **Mean Sunshine Duration**

Sunshine duration or sunshine hours is a climatological indicator, measuring duration of sunshine in given period (usually, a day or a year) for a given location on Earth. It is a general indicator of cloudiness of a location.

For training the network, EBPTA algorithm is implemented and tested for a number of epochs and results are compared for the same. Initially the algorithm is implemented for 150 epochs and the network is tested and mean square error is calculated. Then it is implemented for another 500 epochs and this is continued till the mean square error becomes less than 1%. After training the network, the final weights are used for prediction. The network now predicts the irradiation values for a given time period. These values can then be compared with the original values obtained.

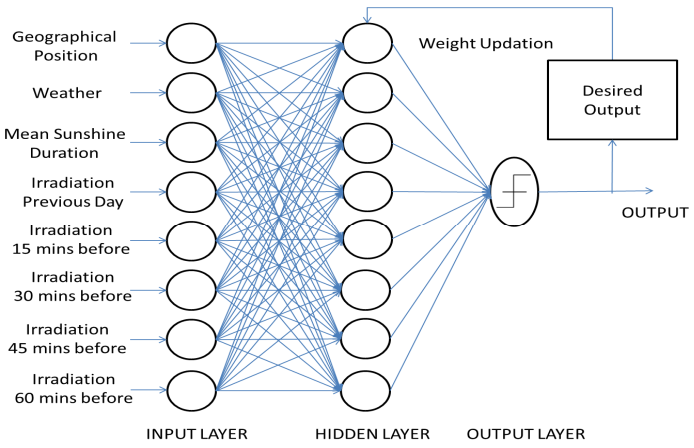

Figure 1: ANN Architecture for Solar Irradiation Prediction

RESULTS

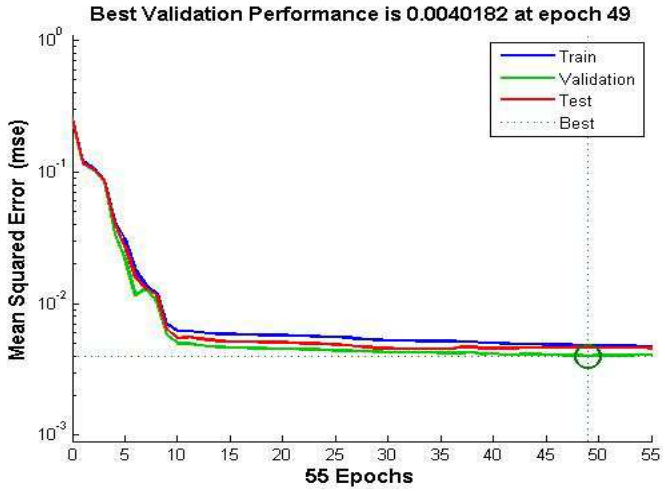

Figure 2: Performance Measure for Implemented Model

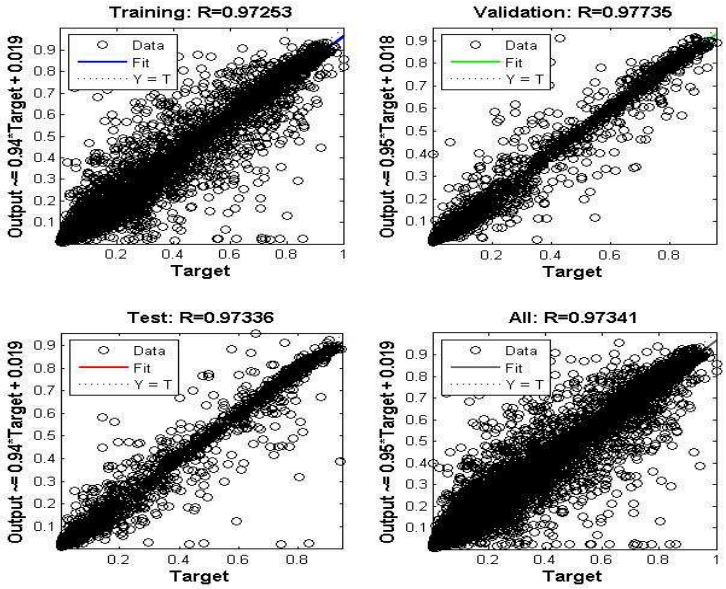

Figure 3: Regression Plot for Implemented Model

CONCLUSIONS

The ANN model as discussed above has considered a number of input parameters after studying the previous work in same domain. The number of neurons in the model has been finalized after testing a number of networks with different number of neurons. The EBPTA algorithm is used for training the network and the training is continued till minimum mean square error becomes 1%. The network may need retraining in future and EBPTA will be used for the same.

In future models, there is a scope for including more input parameters if possible with different network architecture. Also things like condition based cleaning and automating the cleaning processes for solar panels can be implemented to further optimize the solar energy generation from the solar plants. Further, prediction of electricity from wind energy can be implemented in future using neural networks.

REFERENCES

1. Akhil Saokar, Shreyansh Jain, Aruna Gawade, Dr. Gopakumaran T. Thampi, “Neural Network Applications in Solar Irradiance Prediction”, in IJCSE, Volume 2, Issue 5, Issue Date Nov-30 2013, Pg. No. 81-88.